Investigations of Sediment Dynamics in Strataform

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LONG-TERM GOAL

The overall long-term goal of STRATAFORM is to advance our understanding of the development of stratigraphic sequences on continental shelves and slopes. An essential part of this understanding comes from direct measurements of the response of bottom and suspended sediment to oceanic forcing in the study areas. In this project our specific long-term goal is to understand the variability of the sediment response at the seafloor to bottom currents and stresses caused by physical oceanographic forcing. This work is accomplished through statistical and dynamical analyses of available field measurements of wave and current flows, sediment resuspension and concentration, and bottom sediment distributions.

OBJECTIVES

+ Determine the variability in the magnitude and directions of bottom stresses caused by currents, surface waves and internal waves in the STRATAFORM field area off northern California.

+ Estimate time-dependent sediment transport at specific shelf sites in collaboration with other investigators.

+ Develop statistical information and relationships on the response of the bottom sediment to the bottom stresses using measurements from various locations on the shelf.

+ Examine the intense transport events in the bottom-boundary layer measurements to determine the significance of thin, near-bed, high concentration layers (e.g., fluid mud) in transport volumes.

APPROACH

The area selected for the field program is the shelf and upper slope north of the Eel River mouth off northern California. In water depths greater than about 40 m this region is characterized by rather simple bathymetry. Based on samples collected in box cores and from side-scan sonar records, the surface deposits in this area are sandy on the inner shelf (to depths of about 50 m) and grade into mud in deeper water (Wheatcroft, et al., 1996).

We are using time-series data collected with instrumented bottom tripods to do a statistical analysis of primary physical and geological quantities (currents, waves, suspended sediment concentrations, bed elevation changes) and derived sediment transport parameters (wave and current shear velocities, bed stress, roughness scales). These statistics will be combined and evaluated to derive relationships for sediment response and physical forcing. A by-product of this work will be a data base for the measured and derived quantities.

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We also are working with other investigators to estimate time-dependent sediment flux, particularly during energetic storms and river flood events. The significance of high concentration layers near the seafloor in the overall sediment transport conditions is a primary focus of this work.

WORK COMPLETED

- Data base for measurements of bottom boundary layer and other physical measurements has been initiated. This data base will include computed quantities such as bottom shear velocities and roughness length scales, and statistics of primary and derived parameters.

- Dimensional analysis of the shelf mud deposit has been incorporated into this type of analysis for shelf mud deposits at other locations.

- Estimates of sediment transport during storms and flood events has been carried out with other investigators using bottom boundary layer measurements and shelf transport models.

RESULTS

We have shown with others (R. Sternberg and A. Ogston) that seaward transport of fine-grained sediment on the inner to mid-shelf in the STRATAFORM occurs largely within a thin bottom layer. The values of the sediment concentrations within this layer equal or exceed values for fluid muds (>10 g/l). Other investigators (P. Traykovski and J. Lynch) also have evidence from acoustic data that fluid mud is found above the seabed in this region.

Data from time-series CTD data collected on bottom tripods indicates non-linear, bore-like internal tidal motions on the shelf in 60 m depth. Energetic internal tides have also been found in the long-term STRATAFORM mooring temperature and current data at site Y-450 (in 450 m depth on the slope). Internal tidal propagation from slope to shelf areas is likely in this region, and may be significant for transport of suspended materials.

Creation of a data base for bottom boundary layer measurements and estimates of sediment transport parameters is underway. Statistical analyses of these quantities will be carried out in the near future.

IMPACT/APPLICATIONS

The interpretation that fluid mud formed during storm-induced wave and current stresses following a period of high sediment discharge from the Eel River has great implications for the amount of sediment transported on this shelf. If fluid mud forms on shelves that receive large amounts of sediment from coastal rivers, similar to that found off the Amazon river (Kineke and Sternberg, 1995; Cacchione, et al, 1995), then a major mechanism for shelf sediment transport will have been discovered.

RELATED PROJECTS

This project is closely related to other STRATAFORM projects which are involved measurements of sediment transport. These include projects by R. Sternberg, U. of Washington, by L.D. Wright, VIMS, and by J. Lynch and J. Irish, WHOI. In addition, this project provides input to the modeling of shelf transport for STRATAFORM (Wiberg, et al., 1996).

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